Afghanistan RAMP Rebuilding Agricultural Markets in Afghanistan

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Geographic Information System (GIS) Applications for Mapping RAMP Activities and Impacts

by
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REBUILDING AGRICULTURE MARKETS PROGRAM (RAMP)
IN AFGHANISTAN

Funded By U.S. Agency for International Development

Geographic Information System (GIS) Applications for Mapping RAMP Activities and Impacts

Draft Report

By Mohamed Khatouri

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This report was prepared by Mohamed Khatouri of Chemonics International Inc., prime contractor to the U.S. Agency for International Development for RAMP in Afghanistan.

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A. Introduction

This trip report describes the tasks associated with a scoping mission for the use of the Geographic Information System (GIS) by RAMP in Afghanistan, conducted from November 18 to December 12, 2003 at the project office in Kabul.

The main objective of this activity was to assist RAMP in the integration of the GIS as a tool to improve planning, management, and dissemination of program activities and results. The major tasks associated with this trip included:

- Background reviews of the RAMP objectives and expected results within the context of the development of the GIS.

- Initial determination of how RAMP could use the GIS tool to enhance planning and management of program activities.

- Design an approach for the integration of RAMP data with a spatial dimension into GIS for improved spatial and temporal analysis of project interventions, results, and impacts.

What is a GIS?

A GIS is a computer-based system that compiles, stores, manipulates, analyzes, and visualizes spatial data in digital form to facilitate program planning and management. It is a multi-faceted system of hardware, software, data, people, and methods. The importance given to each component depends largely on the goals and objectives assigned to the development of the GIS applications and the overall importance of the GIS to the organization and the program. The result of increases in computer power combined with drastic reduction in cost of computer technology has made the GIS highly accessible and widely accepted as an integrated planning and management tool in various sectors.

GIS data sets are made up of layers or collections of geographic objects called features that may be represented by points (e.g. cities), lines (e.g. roads, rivers) or polygons (e.g. provinces and district boundaries). The map layer represents location of objects specified by their coordinates (x,y). The GIS can also store descriptive information about the feature in its attribute table. Both components have to be linked in order to have the full functionality of the GIS. The link between the map features and their attributes allows the user to query any specific information in the table and display it on the map or identify a feature on the map and see all the information about it in the attribute table. Key to the GIS analysis is spatial overlays to show the location of specific features and their spatial relation to other features of different layers.

B. RAMP Objectives and Activities

Agriculture is the foundation of the Afghan economy. Approximately 80 percent of the population of Afghanistan depends on agriculture, which contributed to more than 50 percent of the GDP in the past.

With decades of conflict, most of the agriculture resources have been destroyed. This has had a devastating consequence on the majority of the Afghan population. More than 50 percent of the total population now lives in absolute poverty. To address these issues, USAID selected Chemonics to implement Rebuilding Agricultural Markets Program (RAMP), one of the largest agriculture programs in its development history, to revive Afghanistan agriculture with a funding of $150 million over a three-year period (2003- 2006). The majority of RAMP activities will be implemented by partners (sub-contractors) using a Job Order (JO) or Grant mechanisms.

RAMP aims to enhance food security and incomes of the rural population. It has two main objectives: (i) increasing agriculture productivity and output; and (ii) increasing incomes through effective linkages among producers, processors, and markets. These objectives will be achieved through several integrated activities that focus on three main components:

- Improved technology and market development
- Rural infrastructure rehabilitation
- Financial services expansion

A flowchart which links program targeted results with planned activities is presented in Figure 1. Most of the RAMP activities and results require large amount of information which is profoundly spatial in nature.

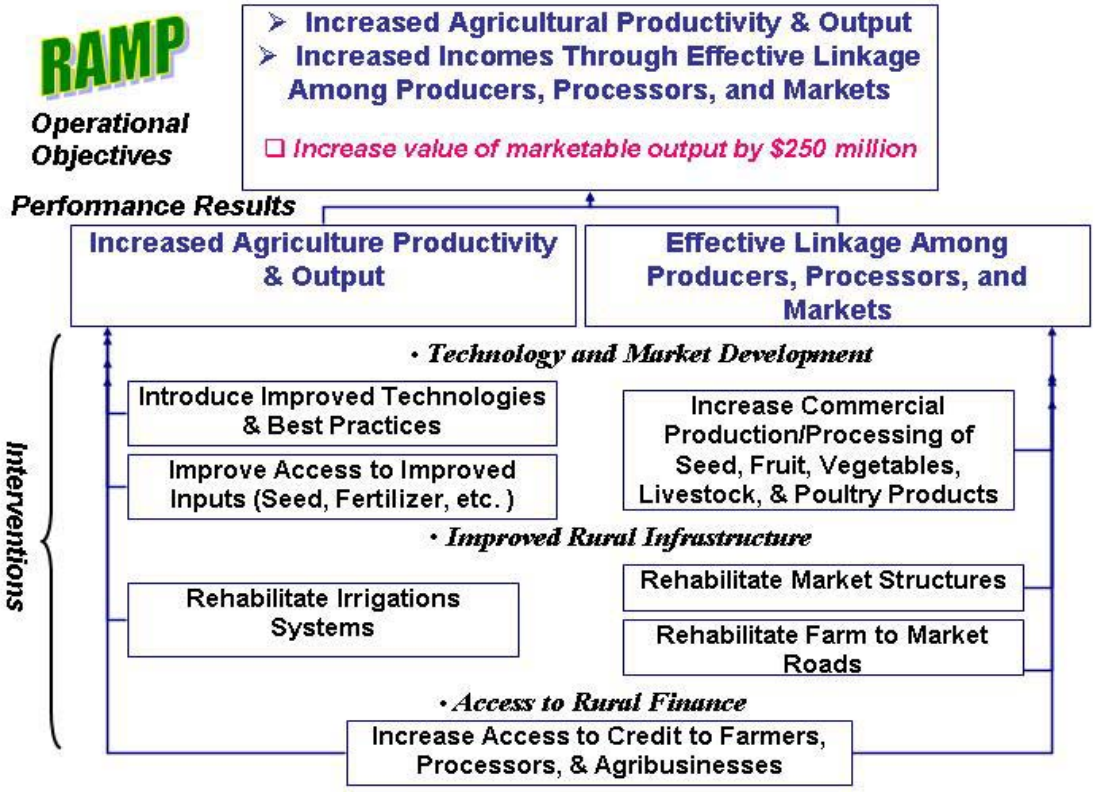

Figure 1. RAMP Objectives Framework Chart

C. Need of GIS for RAMP

The scope of RAMP activities and targeted results is so broad that there is a need for an integrated information system to store, analysis, and display program information. GIS is an effective tool for this type of task and holds considerable promise. Not only will it integrate data from many sources, but it also provides a common framework for sharing data and disseminating information about program activities and results. It can enhance the accessibility and flexibility of information and can improve the linkages and understanding of relationships between different types of information displayed in different GIS layers. GIS technology has been recognized as an essential tool used to locate and visualize project activities and their impacts on existing resources and local population.

Some of the intended uses of GIS by RAMP include the following:

- **Planning.** The GIS capabilities to process various data in spatial domain make the planning process easier and can ensure a better understanding of agricultural and land uses in a given locality. The ability of GIS to integrate, display, and query many types of information at the same time makes it an important tool for decision support and planning of program activities. In the RAMP planning phase, GIS will be a valuable tool for developing information that improves designing activities and selecting areas for maximum geographic impact. It can also help in visualizing program activities and results in relation to other relevant physical, biophysical, and socio-economic characteristics of the region as provided by different layers of GIS.

- **Monitoring & Evaluation.** RAMP is also involved in many activities of monitoring, evaluating, and reporting on program interventions carried out by sub-contractors under the JO or Grant mechanisms in many selected provinces and districts in the country. Prioritizing interventions and ensuring coordination and synergy among different activities can be improved using GIS.

- **Communication.** Improved communication fostered by using GIS can help in promoting and disseminating project results and impacts. The system will be used as a visual analysis tool, and will produce communication output tools such as maps, reports, and charts.

These examples give only a few of the many possible applications of GIS for RAMP. GIS is a flexible and expandable tool where many other uses can be easily added as the supporting dataset is becomes available. Many GIS attributes--its inherent power to present data in its true spatial relationships, its advanced visualization and display techniques, its capacity for alternative strategies and monitoring results--suggest potential applications that go beyond the current objectives.

Approach used

The approach used to integrate GIS into RAMP was based first on the development of pilot GIS applications to show how GIS can be used as an efficient tool to enhance planning and management of geo-referenced data. The presentation of the results of this initial phase would serve as a dissemination tool and a means to involve potential GIS users among different RAMP components to invest time and collect geo-referenced information needed to develop GIS applications. This approach has the advantage of producing a usable product in a short time without waiting for training of GIS staff and procuring hardware and software before having an initial product. Updating of data or enhancement of the product would require further effort, which may be addressed efficiently by providing formal and on-the-job training in GIS to the appropriate staff.

This approach seems to be the most appropriate to achieve the objective of integrating GIS in RAMP. A lot of interest in using the GIS tool was expressed by several RAMP technical staff after we presented the pilot GIS product in a staff meeting. Elements of updating the information could be addressed immediately after procurement of the GIS software and hardware and an initial training was carried out. However, in order to get the best use out of this tool, there needs to be a commitment by all RAMP staff and implementing partners to work together and exchange information on different implemented activities.

Based on the rapid assessment of the integration of GIS as a tool to improve planning and management of RAMP, we came up with three initial applications: (1) application for storing base maps to enhance RAMP planning of field activities; (2) application for geo-referencing and visualizing RAMP activities, and (3) application to enhance the communication of program results and potential impacts.

D. Base Maps to enhance RAMP Activity Planning

This GIS application will address the identified need for base maps for the analysis of spatial patterns and relationships of demographic, infrastructure, land cover, administrative divisions, and other socio-economic data. GIS technology makes program planning a much more dynamic process, with the ability to base decisions on large array of relevant data that are kept current and integrated.

Different GIS layers can be added together and statistical information generated to help give a clear understanding of what exists in a particular geographic region. This analysis is needed in the identification of project activities, selection of new areas for expansion of RAMP interventions, and in the analysis of potential impact of proposed activities on increasing agriculture productivity and improving household incomes.

The base maps representing important layers of administrative and infrastructure information will also serve as a basis for representing and analyzing the spatial location of project activities and results. Integration of basic information into the present GIS application should be limited in the beginning to the strict minimum required to meet the assigned objective.

In order for a GIS to function, the availability of a substantial portion of the base maps in digital form is required before any GIS application development can begin. GIS implementation can be greatly accelerated if some of the data for the GIS operations are already available in digital form. Initial investigation and research among the existing geographic information data was done to evaluate the availability and usefulness of resources information and land use data for developing RAMP project GIS. We found that most of the data exists already in digital form and is accessible in appropriate GIS format (shape files) through the Afghan Information Management Service (AIMS). Several useful base data sets were acquired from AIMS and incorporated into the present RAMP GIS. These include the following layers:

- Provinces limits with 2002 demographic data
- Districts limits with 2002 demographic data
- Primary and secondary road networks
- Cities and villages
- Streams and water bodies

These data layers can be displayed alone or in combination with other layers and can be seen as an important tool in the planning and management of both RAMP activities and in visualizing their impact. Figure 2 shows a GIS "View", which is an interactive map screen that lets the user display, query, and analyze geographic data. Several layers have been added to the view, including province limits, district limits, primary roads, provincial centers, and RAMP priority provinces and districts.

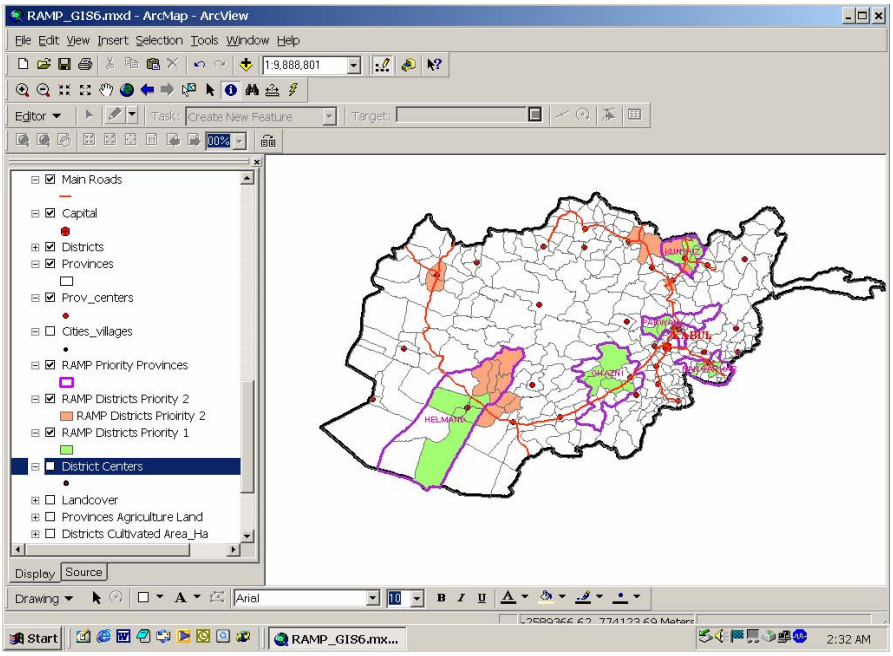

Figure 2. GIS "View" showing examples of baseline map overlays.

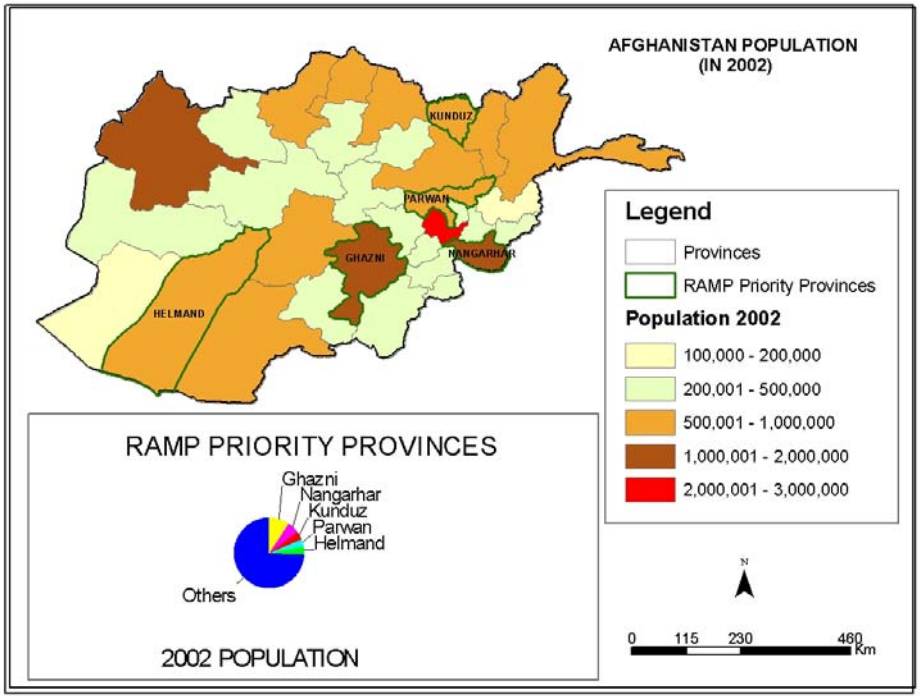

Figure 2. Afghanistan Population in 2002 by Province

A land cover map was also added to RAMP base maps. This map was derived from the map produced through the collaborative efforts of FAO, UNDP and the Afghan Geodesy and the Office in Kabul (2002). The legend was simplified by grouping some of the classes to get a broad land cover map. In the current land cover map (Figure 3) it was found that about 12 % of the total land was used as farmland, 46 % was rangeland, 2 % was forest, and 60 % was other land use (rock, sand, etc).

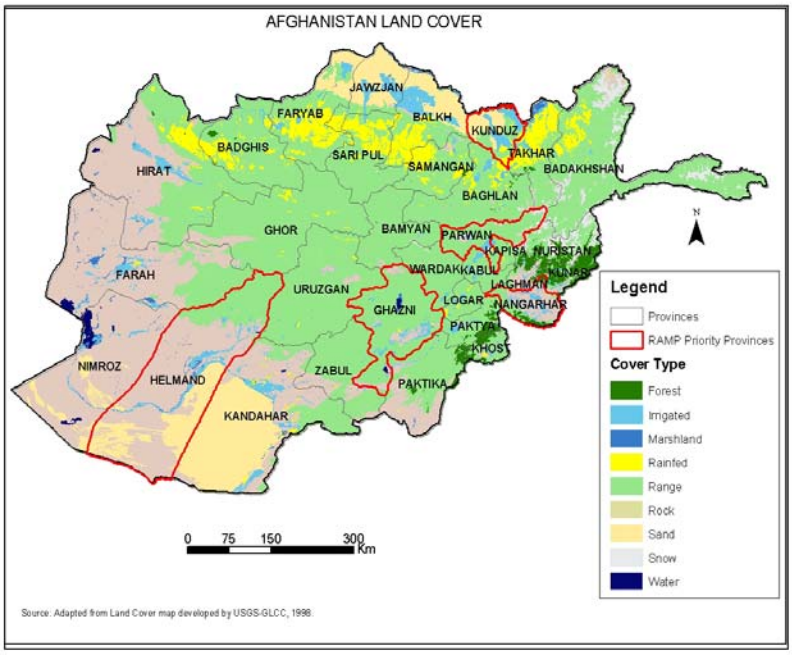

Figure 3. Afghanistan Land Cover

Estimates of irrigated and rainfed areas cultivated in 2003 were added to attribute tables of provinces and districts layers. These estimates of cultivated land were derived using 1993 & 2003 FAO estimates of land cultivated in each district and province. Figure 4 shows maps of areas of irrigated land cultivated in 2003.

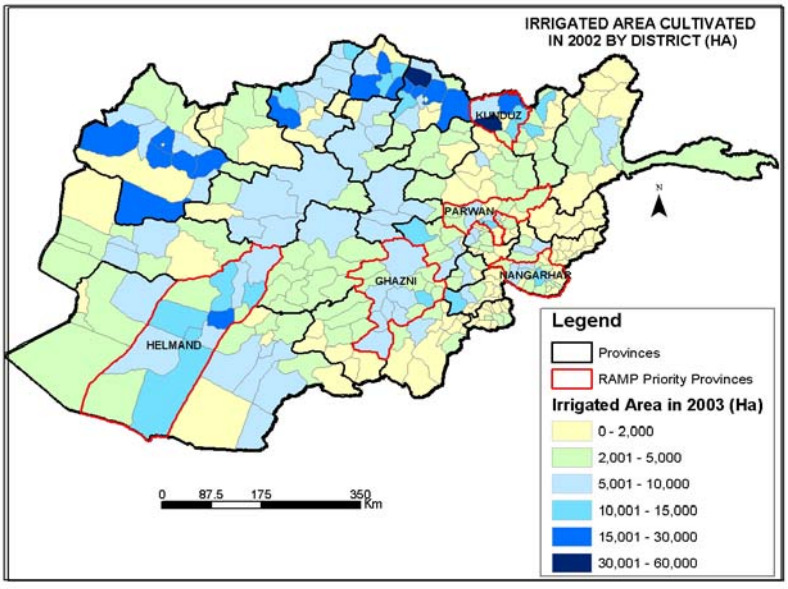

Figure 4. Irrigated Land cultivated in 2002 by district

Visualization of RAMP priority districts and the selection of additional districts for possible extension of RAMP activities constitute an example of using GIS to improve planning. The selection of additional districts was based on superposition of several GIS layers including RAMP priority provinces, land use, roads, cities, demography, and especially the 2003 cultivated land under irrigation. Figure 5 shows the two sets of selected RAMP priority districts.

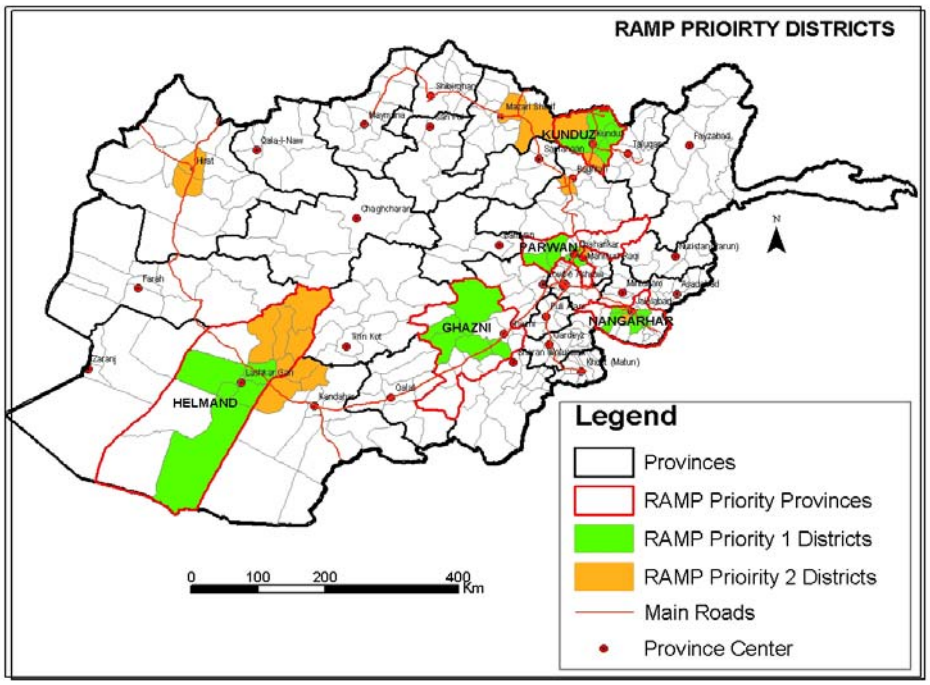

Figure 5. RAMP Priority Districts

E. Integrating RAMP Activities into GIS

This application will be used to integrate all RAMP main field activities with geographic nature into GIS. The idea is to be able to locate on a map all projects and then click on any one of them or select an area to generate related technical information about the RAMP activities. This objective could be easily accomplished using a GIS dataset which includes a layer of points or polygons identifying exact locations of all activities linked to an attribute database containing all the information of interest. Each specific activity will be integrated into the GIS as a separate layer with precise location of the activity defined by its coordinates using a topographic map or a GPS.

The system will utilize multiple polygons or points to represent projects or activities, using diverse symbology. For each geo-referenced activity, additional information should be obtained and included in the associated attribute table. The final list of information to be included in the attribute table must be based on a thorough understanding of the need for its use along with its availability and accessibility. All attributes should be structured and standardized to facilitate their integration into the GIS and later their use in the analysis and visualization on a map.

Activities included in 10 already awarded RAMP JO were integrated into GIS to show examples of integration of data with geographic dimension into a GIS for improved mapping and analysis of RAMP interventions. These activities were grouped into GIS layers and include road rehabilitation, canal rehabilitation, water harvesting, village seed enterprise, improved potato seed production, new technology demonstration, poultry production, protected agriculture, and micro-finance institutions. Currently, there are more than 20 projects (JOs) in the preparation phase. As soon as these projects are approved, activities will be integrated into GIS, either as a new layer or added to the already existing layer based on the nature of the activity. For each project, a shape file was created and related information was entered in the attribute table to facilitate query, analysis, and visualization. Only basic information included in the JO proposal was entered. The exact location of some activities, along with related information to monitor implementation progress and impacts, needs to be completed and updated on a regular basis. Both spatial and attribute data incorporated in RAMP GIS should be kept as current as possible.

E1. Road Rehabilitation

The objective of this activity is to rehabilitate selected rural secondary and tertiary roads to provide farmers with improved access to markets and lower transportation costs. Two JOs for road rehabilitation have been issued by RAMP to two subcontractors to work in two provinces. A shape file (Road-Rehabilitation) containing the sections of roads to be rehabilitated was created. Basic information about each road was entered in the related table and includes the following attributes:

- JO Number
- Subcontractor
- Province
- District
- Road Name
- Photo
- Starting date
- Ending date
- Type of rehabilitation
- Length in Km
- Number of beneficiary farmers

Other information that could be added to the road attribute table includes the anticipated impact in terms of transport cost reduction and increase in market value of agriculture products to be transported from farm to market using the rehabilitated road. Figure 6 represents the localization of the current RAMP road rehabilitation activities.

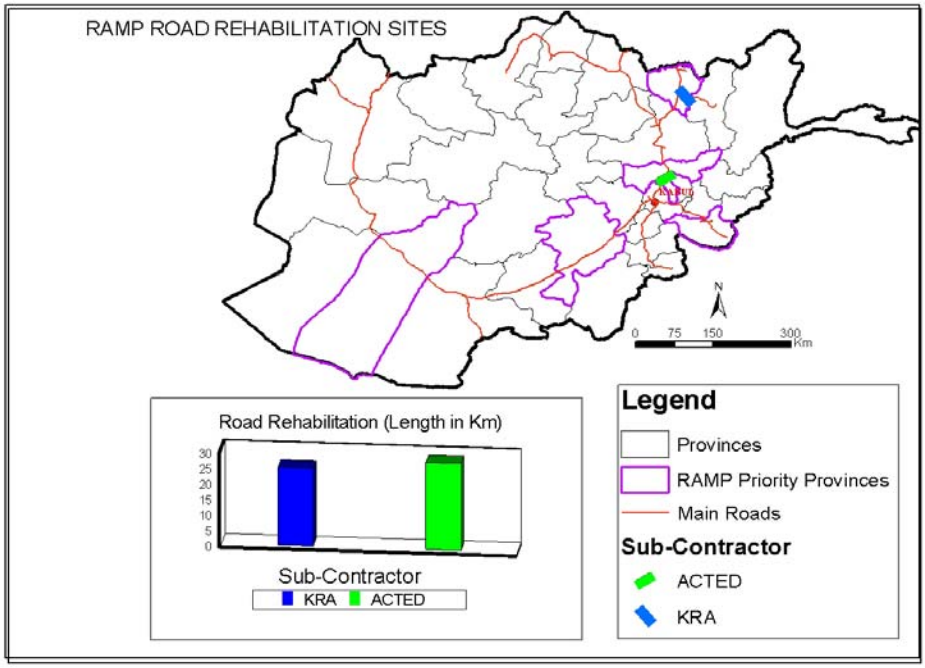

Figure 6. Current RAMP road rehabilitation sites

E2. Canal Rehabilitation

The objective of this activity is to rehabilitate the irrigation systems to minimize water loss and enable farmers to access more irrigated water and therefore cultivate abandoned agriculture land or increase the productivity of existing irrigated land. A shape file containing canals to be rehabilitated under the three issued JOs was created (Canal_Rehabilitation) along with a related attribute table containing the following attributes:

- JO Number
- Province
- District
- Sub-contractor
- Name of the canal
- Starting Date
- Ending Date
- Type of rehabilitation
- Length in Km
- Phone
- Irrigated area in ha
- Number of beneficiary farmers
- Increase in productivity (in $)
- Progress status

Monitoring and impact information have to be quantified and incorporated into the attribute table. Localization of these canals is presented in Figure 7.

E3. Water harvesting

The objective of this activity is to construct check dams or reservoirs to store rain water and recharge the underground aquifers to enable farmers to harvest more ground water to improve

agriculture productivity. One JO was awarded to work in two provinces: Kandahar and Helmand. A shape file (Water_Harvesting) was created with approximate locations of the check dams (Figure 7) with the following attributes.

- JO Number
- Province
- District
- Check dam name
- Starting Date
- Ending Date
- Sub-contractor
- Length in Km
- Photo
- Irrigated land (in ha)
- Increase in crop yield (Tons/ha)
- Number of beneficiary farmers
- Increase in crop yield value ($)
- Progress status

The exact location of each check dam in each district has to be identified once the assessment is completed. Progress status and impact of each dam, such as the number of beneficiary farmers and the increase in crop yield, have to be quantified and added to the attribute table.

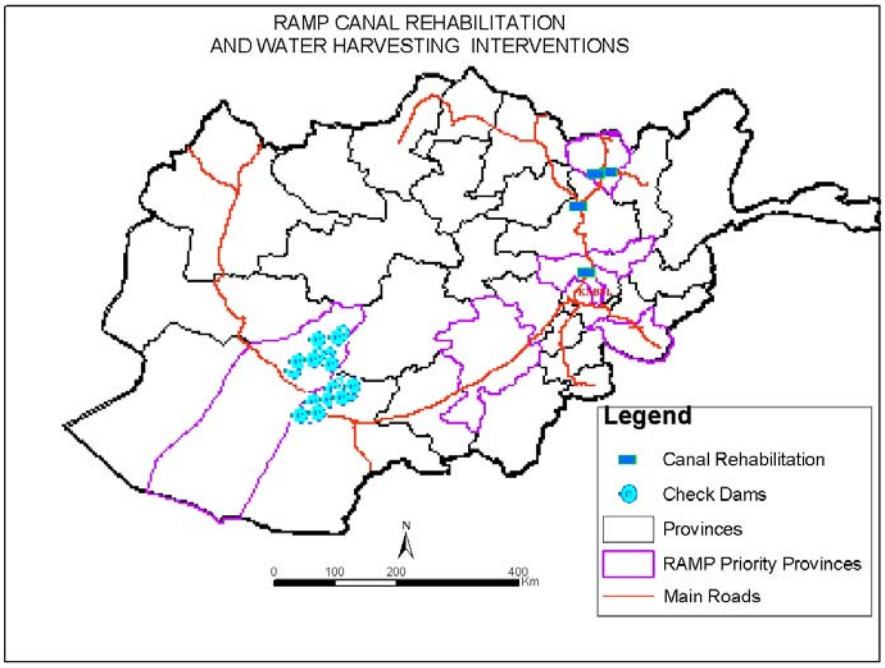

Figure 7. RAMP canal rehabilitation and water harvesting check dam sites

E4. Village seed enterprise

Under this project, village-based seed enterprises (VBSE) will be developed in selected farming communities to produce quality seed to be sold to others farmers in the community to improve agriculture productivity. One JO was issued to develop a total of 20 VBSEs in RAMP priority provinces. A shape file was created (Village_Seed_Ent) and the following related attributes

were added:

- JO Number
- Province
- District
- Village Name
- Sub-contractor
- Starting Date
- Ending Date
- Photo
- Progress status
- Number of VBSE farmers
- Seed Production (in T)
- Total Value of seed Production (in $)
- Number of beneficiary farmers
- Increase in agriculture production value (in $)

The exact location of each VBSE and additional monitoring data should be added once the demonstrations are in place.

E5. Improved potato seed production

This project will support improved potato seed producing groups in selected communities to help increase their income and improve productivity of potato farmers in targeted areas. The related attribute values included in the improved potato seed production shape file (Potato_seed_Production) include the following:

- JO Number
- Province
- District
- Village Name
- Sub-contractor
- Starting Date
- Ending Date
- Photo
- Number of potato improved seed producers
- Progress status
- Area of improved seed production (in ha)
- Improved Potato seed Production (in T)
- Improved Potato seed Production Value (in $)
- Number of farmers using improved potato seed
- Increase in the value of potato production using improved seed (in $)

The exact location of each producing group and additional monitoring data should be added once the activity is place.

E6. New technology demonstration

The objective of this activity is to establish on-farm demonstrations in RAMP priority districts for improved technologies for six main crops, which include key inputs and management practices. The attributes of the new technology shape file (New_technology_demonstrations)

include the following:

- JO Number
- Province
- District
- Demonstration Identification Number
- Sub-contractor
- Starting Date
- Ending Date
- Photo
- Progress status
- Crop
- Water source (rain-fed or irrigated
- Weed control method
- Variety
- Seed rate (kg/ha)
- Number of applied irrigations
- Fertilized rate
- Demonstration area (ha)
- Demonstration yield (t/ha)
- Increase in farmers production (t)
- Increase in the value of farmers production (in $)
- Increase in the market value (in $)

The exact location of each demonstration and additional monitoring data should be added once the demonstrations are in place.

E7. Poultry production

This project will support village level poultry producers in RAMP priority districts to improve breeding stock, health, necessary inputs to raise poultry production, and farm income in the targeted areas. The shape file of the districts where this activity will take place was created (Poultry_production_program) with the following attribute information.

- JO Number
- Province
- District
- Village Name
- Sub-contractor
- Starting Date
- Ending Date
- Photo
- Number of producers
- Number of women trained
- Number of Pullets distributed
- Number of pullets vaccinated
- Number of poultry producer groups
- Number of eggs produced
- Total value of eggs produced (in $)

The exact location of each producing group and additional monitoring data should be added once the activity is in place.

E8. Protected Agriculture

The objective of this activity is to promote the adoption of affordable and sustainable protected

agriculture (greenhouse or plastic houses) to increase the production of high value crops and net income of farmers. A JO was issued for the introduction of 28 plastic house facilities in RAMP priority provinces. This project was integrated into the RAMP GIS by the creation of a shape file (Plastic_house) with 25 potential sites in priority districts.

- JO Number
- Province
- District
- Green House ID
- Sub-contractor
- Starting Date
- Ending Date
- Photo
- Progress status
- Crop
- Green House Production (in tons)
- Production Value (in $)
- Net Return without Green House (in $)
- Net Return in Year 2
- Green House Area (in Ha)

The exact location of each site will be corrected and the related attribute information completed once the plastic house is established.

E9. Micro-finance institutions

The objective of this project is to provide direct loan capital to microfinance providers to increase access to credit for the agriculture sector. RAMP, under the current MISFA JO will be providing financial and technical assistance to a number of qualified microfinance providers to extend microfinance services to rural areas with the objective of reaching 9,000 to 36,000 clients at the end of the first 18 months. Currently there are approximately 9 MFIs in Afghanistan. A layer identifying the locations of MFIs linked to an attribute table containing all the information of interest was incorporated into the GIS (Microfinance_institutions) and include the following attributes:

- MFI Acronym
- MFI Name
- City
- Office type
- Address
- Phone
- RAMP grant amount ($)
- Number of clients
- Number of active loans Portfolio

The idea of integrating this layer into the RAMP GIS is to be able to locate on a map all MFIs and then click on any one of them to generate related financial information about these institutions. The localization of each MFI headquarters and branches was presented by a point defined by the city or village localization (Figure 8). The exact localization, when it is provided, could be found under the address field in the table of attributes for each MFI.

Additional financial data disaggregated by geographic location could be added later.

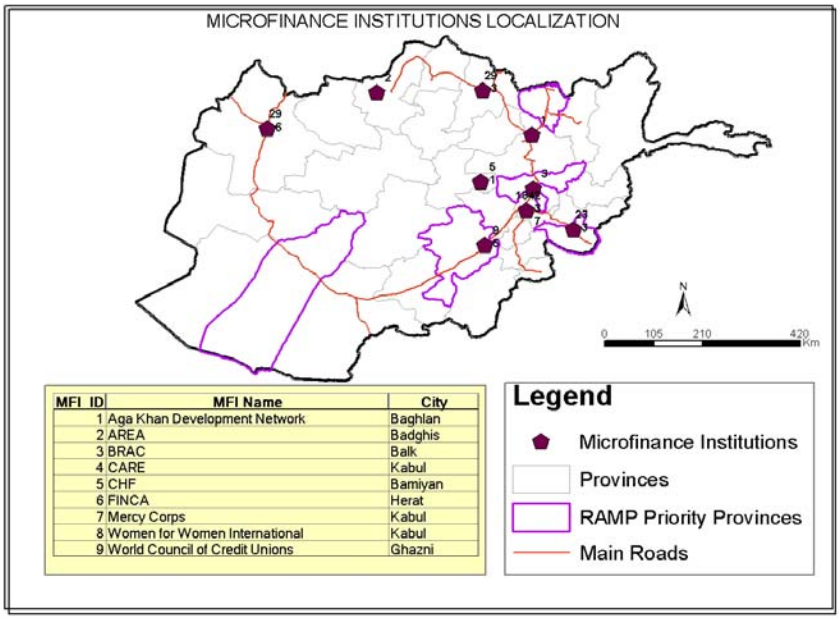

Figure 8. Microfinance institutions localization

F. GIS application for RAMP Results Communication

As RAMP activities and impact grow and reach a large number of farmers spread all over the priority districts, the need for an information system to track and report results and impacts in an integrated way increases. RAMP M&E unit is currently coordinating this effort by collecting basic information about each activity. Linking the current information included in the M&E system to the GIS could result in a more efficient tool that uses spatial queries and analysis.

Combining M&E data with the geographical location from the GIS, can also provide important analysis to RAMP managers to visualize and disseminate the program results and impact to USAID, stakeholders, and to a larger audience.

A map showing before and after situations could be used to show both the impact of each activity and the impact of several activities at a given district or region using GIS spatial overlay analysis. Two examples were developed to show how GIS could be used to demonstrate the RAMP impact: (i) Anticipated RAMP Demonstration Impacts in the RAMP priority districts (Figure 9) and (ii) Anticipated impact of canal rehabilitation in one of the irrigated perimeters (Figure 10).

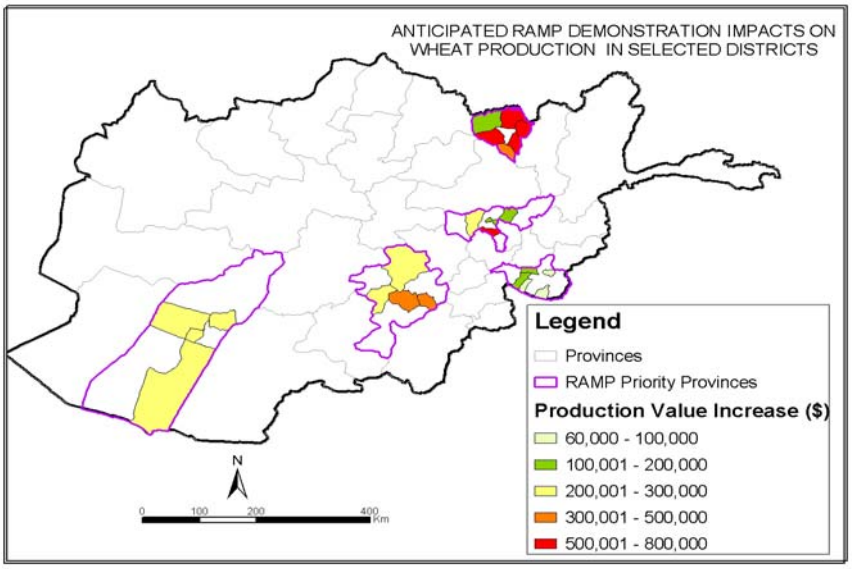

Figure 9. Anticipated demonstration impacts on wheat production in selected districts

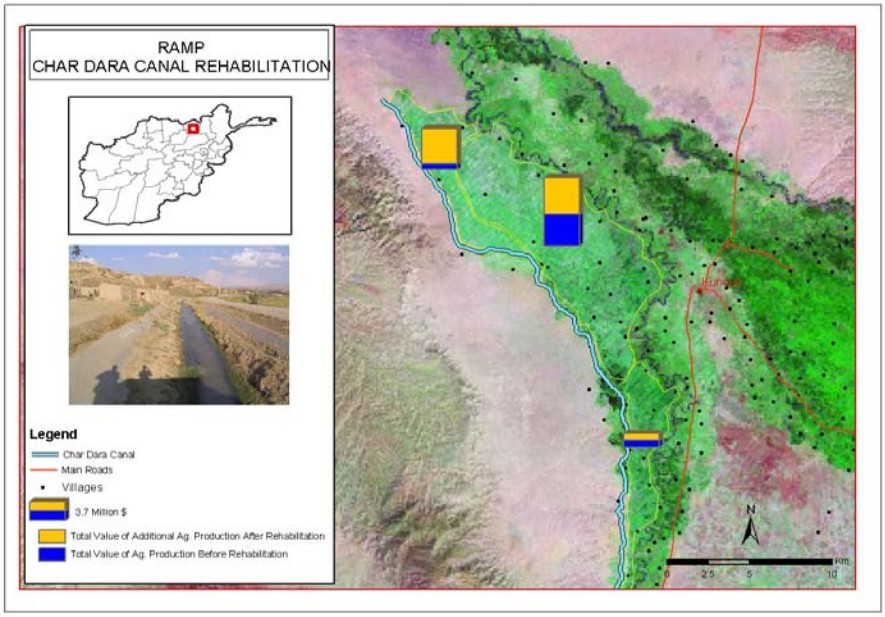

Figure 10. Anticipated Char Dara canal rehabilitation impacts on Agriculture production

G. Recommendations for Next Steps

This first phase of the GIS scoping mission was very helpful in many aspects. It helped us develop an initial understanding of the RAMP objectives and targeted results in relation to the development of the GIS. This work has laid the foundation from which to continue building applications that can be used to communicate awareness of RAMP activities and results. The following recommendations are proposed in support of the development and incorporation of

GIS into RAMP for improved spatial and temporal analysis of project interventions, results, and impacts:

- **Software Procurement**

Procure and install GIS software and hardware to support the development of the RAMP GIS applications. A copy of the latest version of ArcGIS (ArcView 8.3) from ESRI was ordered and will be installed in one of the RAMP computers in the next few days. ArcView was chosen because it is the common GIS used all over the world. It is user-friendly and relatively inexpensive. The latest version is ArcView 8.3 and costs around $1500. This will provide the RAMP team the baseline operational capability to perform basic GIS activities of updating, analyzing, and visualizing GIS data. When the need arises, a second GIS license could be procured to ensure continuous operation capabilities and allow for another person to work concurrently, such as an application development on one computer and data development and update on the other computer.

- **Hardware Procurement**

There are several options for the procurement of GIS hardware equipment. As the RAMP GIS becomes operational, there will be a lot of demand for hard copy maps from RAMP staff, stakeholder, and implementing partners. A color printer and a plotter are required for the production of GIS outputs and maps. However, GIS staff has to be very careful not to turn the GIS work into a map production lab. Reproduction of hard copy maps should be limited to the strict minimum and the focus should be on mapping RAMP activities, results, and impacts.

- **GIS staff and training**.

The M&E unit is a logical place to house the GIS, since one of the main objectives of the RAMP is the integration, analysis, and dissemination of project activities and impacts. GIS activity could be added to the SOW of one of the existing long-term persons or a new local person could be hired to support it. The long-term M&E specialist would supervise the whole activity. However, the level of experience in using GIS is limited and therefore additional formal and on-job training should be provided to the RAMP team involved in the use of the GIS with emphasis on meeting GIS operational requirements for data acquisition, application development, and map production. ESRI provides formal courses in different USA regions, including Washington DC region, on the use of the GIS on a periodic basis, and it would be very beneficial for the M&E specialist to attend one of these courses to gain sufficient knowledge to use the GIS as an integrated part of the M&E process. Additional training could be provided at the project office for all staff involved in the development of the RAMP GIS. The training will increase the ability of RAMP M&E unit to coordinate programs, enhance presentation packages, and build systems that could be applied to all USAID activities in Afghanistan.

- **GIS web application**

Once enough data on RAMP activities and impact has been developed and incorporated into the GIS, it is recommended to develop a GIS web application to make RAMP activities and results more readily accessible to a larger audience. Visitors to the site can also query the available data and view maps for the entire country or just one province or district.